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Greening the Goods Line

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Summary

Greening the Goods Line is a research project aimed at evaluating the social, economic, and environmental changes emerging from the redevelopment of public open space in inner Sydney referred to as 'the Goods Line'. The research explores the social and biophysical changes that have resulted from the redevelopment, and the extent to which any identified changes are related to increases in green space. The research also tests the utility of an evaluation framework for green space development, collaboratively developed between the research team and industry stakeholders. The research is aimed at informing industry stakeholders, public and private sector urban planners, and the general public with an interest in understanding the benefits of green space.

The research focused on changes attributable to the redevelopment of the northern half of the Goods Line (the Goods Line North), completed in 2015. Participant questionnaires, direct observation (including time-lapse photography analysis), and interviews were used to assess social and economic attributes. An air quality study, stormwater runoff modeling, and a bird survey were used to assess biophysical attributes. Because the Goods Line North was not accessible to the general public before the redevelopment, an evaluation of the social, economic, and biophysical attributes of the southern half of the Goods Line (the Goods Line South) was undertaken using the above research methods to provide a surrogate evaluation of baseline conditions.

The research found that the redevelopment of the Goods Line has delivered a high quality public open space that is well used by the local community and others from further afield. The site serves as an important pedestrian corridor connecting local attractions and as a welcome space for local workers and students to take a break, enjoy lunch, or otherwise relax. The site enables both social interaction and solitude, which is a flexibility of the site that was not necessarily implied by a strict reading of the project's evaluation framework. Participants felt the site could be improved with more amenities as well as programming such as events or markets.

The research determined that visitors to the Goods Line North have a strong affinity for green space, with green space being the most commonly mentioned attribute of the site that they liked. Visitors had a greater affinity for the Goods Line North when compared with the Goods Line South, and felt the Goods Line North had better amenities, green space, and brought more people to the area. The site demonstrated the importance of not only providing green space but also the amenities necessary to support public enjoyment of the space, such as a range of seating, tables, and other facilities.

The stormwater runoff modeling showed that the redevelopment contributed to an almost ten per cent decrease in runoff rates. While the air quality study found no significant impact on air quality attributable to the redevelopment, it may have contributed to mitigation of some pollutant concentrations on hot days.

While this research project was able to suggest how the redevelopment has affected the social and biophysical fabric of the area, the Goods Line and its surrounds continue to change as adjacent areas such as Darling Harbour are redeveloped. This research may thus serve as the starting point of a longitudinal study that establishes how the contribution of the Goods Line to the local area matures over time and as its surroundings change.

Keywords

Green space, open space, urban planning, evaluation, benefits, Sydney

1. Introduction

Greening the Goods Line is a research project aimed at evaluating the social, economic, and environmental changes emerging from the redevelopment of 'the Goods Line', a public space in inner Sydney. The study was commissioned by Horticulture Innovation Australia (Hort Innovation) and contributes to the *2020 Vision*, a campaign that aims to promote a twenty per cent increase in green space by 2020. *Greening the Goods Line* delivers an independent evaluation of the type and scale of changes that emerge from urban renewal projects that increase the amount of green space in an area. This research contributes to a growing evidence base of positive outcomes associated with increases in green space, and thus hopes to promote inclusion of green space as a vital component of urban planning and renewal.

1.1. Background

As the built environment expands and population densities grow, urban vegetation is becoming increasingly important for social and environmental health outcomes (Brown et al, 2013; Kahn & Kellert, 2002; Rodhe & Kendle, 1994). Improvements in human health from living green infrastructure have been linked to the protection against the urban heat island effect (Akbari et al, 1992; Rosenfeld et al, 1996; Norton et al, 2013; Jacobs & Delaney, 2015; Norton et al, 2015) reduction in cardiovascular health and chronic diseases (Astell-Burt et al, 2014), improvements in community safety and reduction in crime (Kuo & Sullivan 2001) improved physiological wellbeing (Kaplan & Kaplan 1989) greater storm water retention and improved water quality (Wong 2006), and improved biodiversity (Alvey 2006), pollution and ecosystem services (Bolund & Hunhammar 1999). While these studies employ a range of methodologies, and focus on different demographics and geographies, they support the positive contribution of vegetation for each social and environmental outcome. A comprehensive literature review is outside the scope of this study, however there are a number of research papers that detail the breadth of findings on the effect of vegetation on social and environmental health, including Ely & Pitman (2013). *Greening the Goods Line* contributes to the growing body of work in the green infrastructure research space through the evaluation of an urban site at the local scale.

1.2. Industry relevance

The Nursery & Garden Industry Australia (NGIA) Strategic Plan 2010-2015 (NGIA 2010) emphasizes the importance of profitability and productivity.

Greening the Goods Line is aligned with Strategic Plan Objective 1; 'Increase the sales value of green-life products and services through marketing and promotion'. The first initiative outlined in support of this objective is 'the implementation of a national marketing promotion encouraging people to have more plants in their lives and educating them on the benefits of plants'. The *2020 Vision* is this national campaign, launched in November 2013. One of the primary ways in which this marketing campaign will work towards promoting the value of green life is through the publicity and circulation of independent empirical research such as *Greening the Goods Line*. *Greening the Goods Line* results may be used by the *2020 Vision* marketing campaign to promote increases to green space in urban areas.

1.3. Aims of study

Greening the Goods Line evaluates the social, cultural and environmental changes that can emerge from the redevelopment of a public space that includes green space. While the assessment of changes related to green space is an integral part of the project, the research will also consider how other components of the Goods Line redevelopment (e.g. public amenities), contribute to a visitor's broader experience.

The following research questions guided the study:

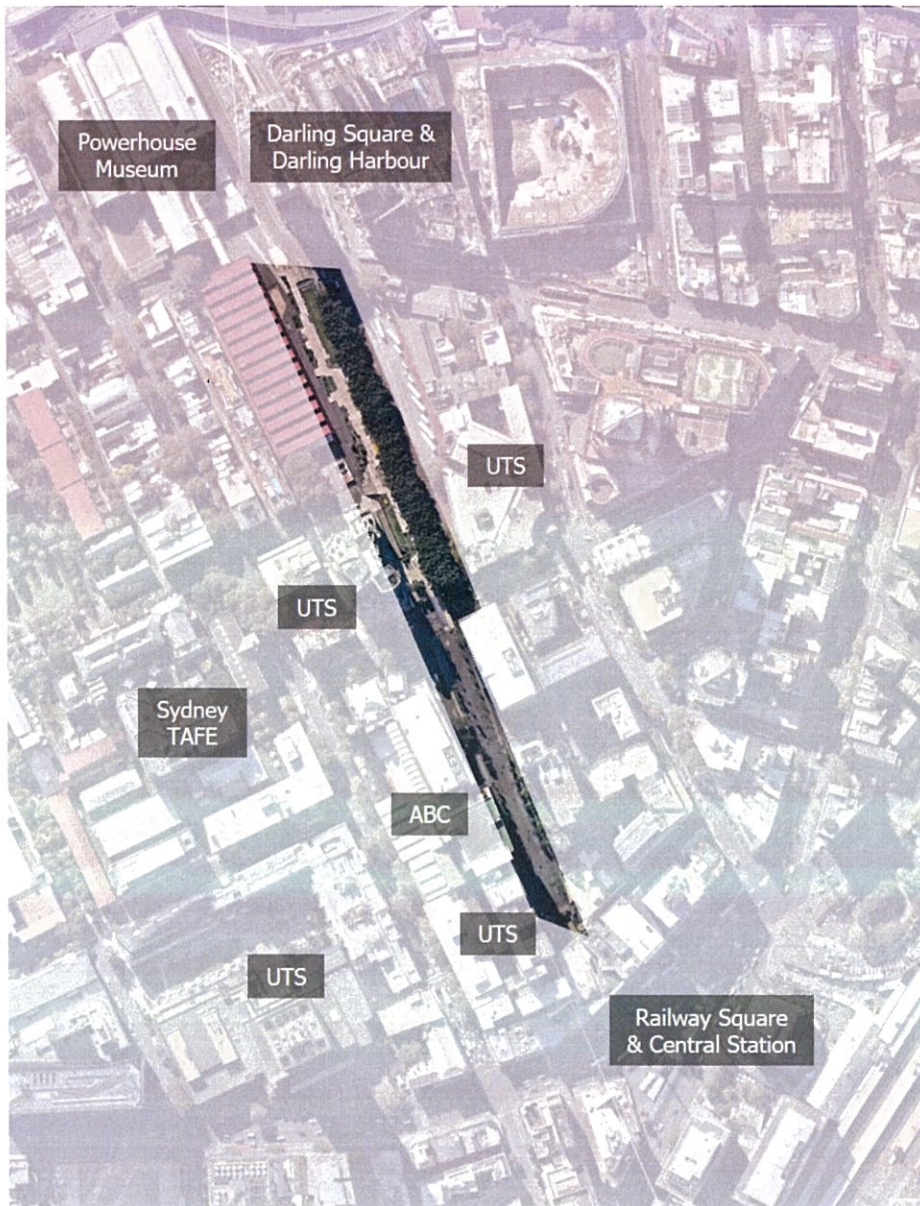
- a) What are the social and biophysical changes that have resulted from the redevelopment of the Goods Line into public open space?
- b) To what extent are any social and biophysical changes related to increases in green space?
- c) Which are the key evaluation criteria that should be applied to open space redevelopments that include green space to determine an accurate measurement of change?

The study provides a high-level overview of the social and environmental changes that have occurred at the Goods Line. The study does not attempt to isolate the strength and weight of specific contributions from environmental or social 'variables' to the visitor experience on the site. Any analysis of public place is highly site-specific as each site has a number of distinctive attributes and characteristics that determine how and why a local community engages with the space. Therefore, the conclusions of this study are not intended to apply universally or be generalized to other sites. Rather, the study contributes to the growing library of site-specific studies that present the breadth of possible changes from urban developments that include green space.

1.4. The Goods Line site

The Goods Line site refers to a disused railway corridor that passes through the inner Sydney suburbs of Ultimo and Haymarket. The site is situated among key attractions such as the Australian Broadcasting Corporation (ABC), the University of Technology Sydney (UTS), Sydney TAFE, the Powerhouse Museum, Darling Harbour (including the forthcoming Darling Square development), Railway Square bus interchange, and Sydney Central Station (Figure 1). The Goods Line is public land, owned and managed by the Sydney Harbour Foreshore Authority (SHFA).

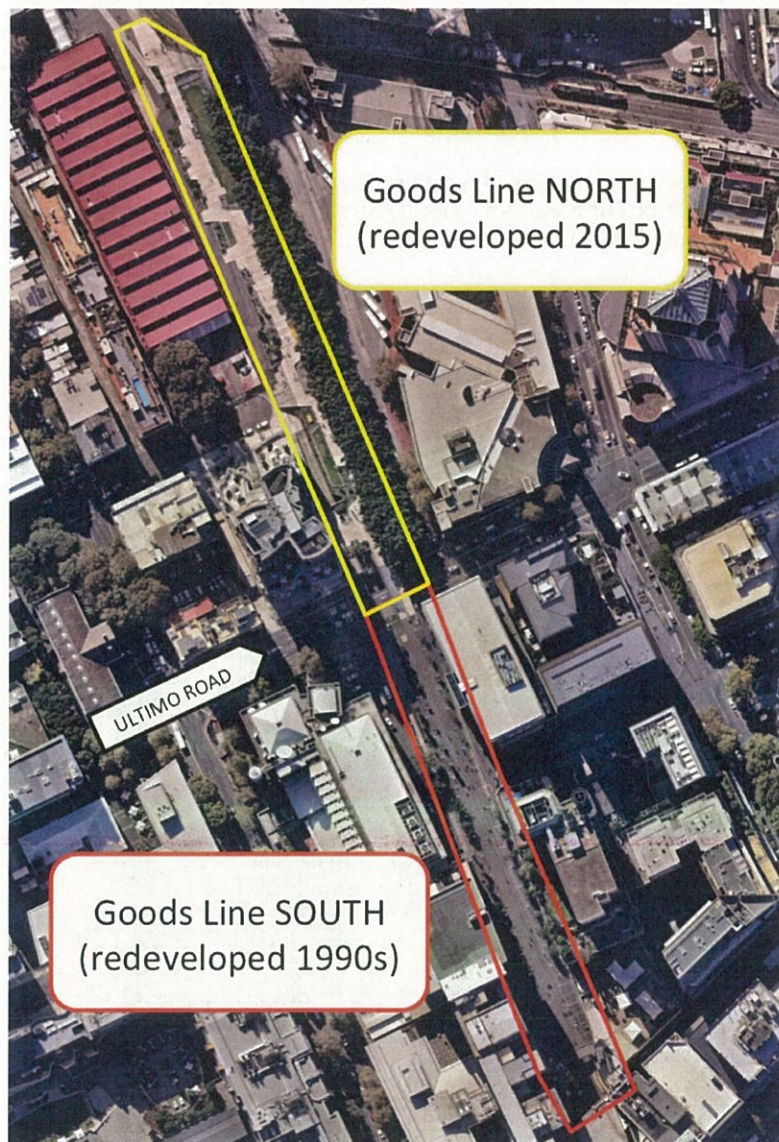
Figure 1 Location of the Goods Line among surrounding attractions. Aerial photography courtesy of nearmap ltd (au.nearmap.com).



The redevelopment of the Goods Line from a disused railway into a public open space occurred in two phases over the past twenty years. The first phase of redevelopment of the Goods Line into a pedestrian corridor occurred in the 1990s and focused primarily on what is referred to in this report as the Goods Line South, or the section of the Goods Line bounded by Ultimo Road to the north and an access tunnel to Railway Square/Central Station to the south (Figure 2). The Goods Line North, being that section of the Goods Line bounded by Ultimo Road to the south and the Powerhouse Museum to the north, was generally inaccessible to the public until the second phase of the redevelopment in 2015. The redevelopment of the Goods Line North had the aim of transforming the area from an

'industrial relic on the city's western fringe into a linear and connected, elevated city park'¹. The Goods Line North and Goods Line South are connected by a pedestrian bridge across Ultimo Road.

Figure 2 Aerial photograph of the Goods Line delineating its northern and southern halves. Aerial photography courtesy of nearmap ltd (au.nearmap.com).



While the entirety of the Goods Line functions as public open space, the Goods Line South and Goods Line North differ in character. The Goods Line South consists almost entirely of paved areas. There is neither grass nor ground vegetation, except for two rows of street trees planted along most of the length of the section that provide limited canopy. Buildings of six or more storeys bound nearly all of the Goods Line South. A number of park benches are available for use, however the Goods Line South contains no other amenities intended for public recreation or rest.

¹ As stated on the *202020 Vision* website. <http://202020vision.com.au/project/?id=152>

Redevelopment of the Goods Line North resulted in the transformation of an uninviting area with no ground vegetation into a diverse urban park with a range of ground vegetation and other open space infrastructure (Figure 3). Between the Goods Line North and Darling Drive (to the northeast) is a line of large fig trees that provide a dense canopy that extends over the eastern half of the Goods Line North. These trees existed before the redevelopment as can be seen in Figure 3. The only buildings adjacent to the Goods Line North are the UTS Business School Dr Chau Chak Wing Building (approximately 12 storeys) to the southwest, and a low-rise warehouse-style building along its western boundary.

Figure 3 Aerial photographs of the Goods Line North before and after its redevelopment. The May 2016 image also shows the completed Dr Chau Chak Wing building along the site's southwestern boundary. Aerial photography courtesy of nearmap ltd (au.nearmap.com).



While an increase to the green space on the site is a notable feature of the redevelopment, Table 1 outlines additional public amenities provided in the Goods Line North.

Table 1: Public amenities and other features included in the redevelopment of the Goods Line North.²

Seating	<ul style="list-style-type: none"> • 125m of custom designed seating
Study pods	<ul style="list-style-type: none"> • Study pods including bench seating. • A communal table with integrated power outlets for laptop and device charging.
Electricity	<ul style="list-style-type: none"> • 3-phase power is provided at intervals throughout – for larger events (including a 50amp outlet for even bigger events)
Internet	<ul style="list-style-type: none"> • Public WIFI has been provided throughout the entire Goods Line
Drinking water	<ul style="list-style-type: none"> • Bubblers and water bottle fill stations throughout
Fitness	<ul style="list-style-type: none"> • A fitness station • Table tennis tables
Playground	<ul style="list-style-type: none"> • A children’s water play playground is included and includes a remnant sandstone culvert discovered on the site
Waste collection	<ul style="list-style-type: none"> • Custom bins provide for both rubbish and recycling
Bike racks	<ul style="list-style-type: none"> • Bike racks are positioned at key entry points
Green space	<ul style="list-style-type: none"> • 2398m² increase in green space including open turf, tree and garden beds

As the design of the Goods Line North redevelopment includes increased urban green space, the site was selected by Hort Innovation to act as a case study to evaluate the social and environmental changes that can emerge from urban development projects. As the Goods Line is a public space in a densely populated professional and educational precinct, the addition of green space to the Goods Line may contribute to the health, well-being and productivity of professional, student and residential populations.

As part of the *202020 Vision*, this study has a particular interest in the role of green space in promoting social, environmental and economic change. The size of the Goods Line redevelopment site spans 7130 square metres, with 2398 square metres (33%) of the surface cover comprising green space as defined in Table 1. This is an increase from a complete absence of green space within the Goods Line North site boundary prior to the redevelopment. The tree canopy between Darling Drive and the Goods Line North was unchanged by the redevelopment. As the redevelopment of the Goods Line North included provision of public amenities additional to green space (Table 1) the study will not conclusively attribute any change to green space alone, but rather will evaluate the range of factors that contribute to an enhanced user experience, including the role of green space.

² Provided by ASPECT Studios, 2015

2. Methodology

Greening the Goods Line commenced in November 2013 and concluded in July 2016. The research adopted a collaborative design, involving both Hort Innovation and NGIA in the design iterations to ensure the project met the stakeholder expectations and adequately responded to the research brief.

The research was designed with regard to the overarching aim of the project – to evaluate social and biophysical changes resulting from the redevelopment of the Goods Line. A transdisciplinary approach guided the design and analysis phases to ensure the findings capture the complexity and nuance of public space engagements. Evaluation design involved moving away from looking at the world through a single disciplinary lens, but to 'transit from one [discipline] to the other, attaining glimpses from different levels of reality generating reciprocal enrichment that may facilitate the understanding of complexity' (Max-Neef 2005, p.15).

2.1. Evaluation Framework and Indicators

At the commencement of the project an evaluation framework was drafted in partnership with the Project Steering Committee. The evaluation framework (Table 2) summarises the aims and objectives of the research and presents an overview of the variables, data collection methods, and expected outcomes for each component of the research. As the research has progressed, the evaluation framework has been modified to reflect the shifts in research design (such as amending methods used because of data availability or other limitations).

Developing an evaluation framework ensures that:

- the research design, methods, data collection and analysis respond to the research aims and objectives
- each of the varied stakeholders contribute to the research design, ensure their specific research needs are met, and feel confident and familiar with the direction of the research.

The evaluation framework and its indicators presented here serve as a guide to assist in measuring and interpreting a wide range of social, cultural and environmental changes rather than an inflexible way of containing the analysis. The research not only reports on the indicators in the evaluation framework but also considers their meaning and relevance for studies of this nature. The analysis will consider performance of the Goods Line North against each indicator while also analysing broader phenomena evident from considering the site as a whole.

Table 2: The evaluation framework developed to guide the research design and interpretation of results.

valuation of;	Expected outcome	Indicators	Data sources
High level outcomes	An urban green infrastructure development with improved social, environmental and economic attributes.	Improvements in; <ul style="list-style-type: none"> • Frequency and duration of use • Breadth of activities • Health and wellbeing • Stimulating local economic activities • Air quality • Peak flow storm water runoff • Biodiversity – birds 	Questionnaires Interviews Direct observation Photography analysis Air quality sampling Modeling of peak flow flooding events
social attributes			
situation of space			
quantities	An increase in the number of people using the site	1. Number of people using the site	Questionnaires Direct Observation
duration	People stay in the space for longer	2. Time spent in the space	Questionnaires Direct Observation
diversity	A diversity of people using the space	3. Uses of the space by age and gender	Questionnaires Direct Observation
uses and activities			
breadth	A broad range of activities undertaken in the space	4. An increasing number of activities taking place in the space	Questionnaires Direct Observation
health and wellbeing			
physicality	The site is used for physical activity	5. An increase/evidence of physical activity	Questionnaires Direct Observation
sedentary activity	The site encourages sedentary activity and relaxation	6. An increase/evidence of sedentary activity and/or relaxation	Questionnaires Direct Observation
interaction	The space encourages increased social interactions	7. The number of social interactions in the space	Questionnaires Direct observation
space attachment			
community	There is an increased sense of community attachment in the space	8. Self reported sense of community 9. Reported vandalism	Questionnaires Interviews

physical	There is an increased affinity towards the physical space	10. Self reported affinity towards the built environment	Questionnaires
nature	There is an increased affinity towards the natural environment space	11. Self reported affinity towards the natural environment	
safety	An increased perception of safety within the space	12. Self reported perception of safety within the space	Questionnaires
Environmental Attributes			
air quality	Improved air quality on the site	13. Air quality sampling assessments	Weekly site and reference sampling
peak storm water runoff	A reduction in the storm water runoff from the site	14. Storm water peak flow assessment	Stormwater runoff modeling
biodiversity	An increase in the biodiversity on the site	15. Assessment of bird life	Bird surveys
Economic Attributes			
new businesses	Increased activity with new businesses	16. Count of new business start ups	Direct observation Interviews
existing businesses	Increased business activity with existing businesses	17. Self reported assessment of small businesses operating on the site and immediate surrounds	Interviews

2.2. Social Research

The research design for social attributes drew upon a triangulation of data to verify the results, highlight limitations and/or errors, and provide a more robust representation of the human experience. These methods included semi structured interviews, direct observation (including time-lapse photography analysis), and on-site participant questionnaires. This multi-method design aimed to provide insights into usage patterns, as well as the reasons and influences underpinning engagement with the public space.

2.2.1. Surrogate baseline evaluation of Goods Line South

As discussed earlier, *Greening the Goods Line* focuses on the redevelopment of the Goods Line North. Evaluating changes resulting from the redevelopment would normally require assessing the baseline conditions prior to redevelopment, and comparing with an end-state, post-redevelopment, assessment. However, a baseline assessment of the Goods Line North was not possible because the site was not accessible to the general public prior to the redevelopment. Because a true baseline assessment of the Goods Line North could not be undertaken, the social and economic attributes of the Goods Line South were assessed as a comparator site for post-development research results from Goods Line North.

The evaluation of the Goods Line South was undertaken in March-May 2014, prior to the redevelopment of the Goods Line North. This evaluation captured a snapshot of usage patterns and conducted a brief assessment of the user experience. The results of the Goods Line South evaluation and Goods Line North evaluation (described in greater detail shortly) were compared to understand how differences in user experience exist between the two areas, and whether any differences may be related to the different characters of the areas. Section 1.4 described how The Goods Line South and Goods Line North differ with respect to green space and other open space infrastructure.

The data gathered from the Goods Line South and Goods Line North evaluations are derived from different sample groups, sample sizes and at different locations (along the Goods Line development). As a site-specific analysis, only members of the general public who are on the Goods Line site at the time of data collection are requested to participate in the research. For these reasons, this is a non-random sample and not statically valid for a comparative analysis (i.e. Goods Line South group compared with Goods Line North group). To partially overcome some of the challenges presented from these differences and to strengthen the reliability of the comparative analysis, the Goods Line North questionnaire (to be discussed shortly) has retrospective elements to capture the opinions and activities of respondents who had previously spent time at the Goods Line South. These retrospective questions in the social research for the Goods Line North support the social research undertaken on the Goods Line South when comparing visitor experiences and perceptions of the two sites.

A full report detailing the method and results of the Goods Line South evaluation is provided at Appendix A. The rest of this section focuses on explaining the social research methods used in the evaluation of the Goods Line North. Participant questionnaires, direct observation, and interviews focusing on the Goods Line North were undertaken during April-May 2016. As for the evaluation of the Goods Line South, the approach to the Goods Line North assessment was undertaken during University session times to capture a representative snapshot of the site.

2.2.2. Participant Questionnaire

The participant questionnaire enabled the collection of a core data set for the social research focused on

the Goods Line North. The questionnaire comprised five sections (the questionnaire itself is provided at Appendix B):

- Section A: General attitudes – contained five open questions to assess why participants visited the Goods Line North and what they liked or did not like about the site.
- Section B: Previous use – contained one closed question assessing whether participants had previously visited the Goods Line South, and if so, asked three additional questions eliciting comparisons between Goods Line South and Goods Line North.
- Section C: Sentiments – contained closed questions asking participants to indicate frequency of conducting certain activities on the Goods Line North (and comparing this frequency to their visits to their Goods Line South, if applicable), whether they work or study on the Goods Line North alone or with others, whether they agree with specific statements on the Goods Line North's appeal (and comparing this to the appeal of Goods Line South), and their opinion as to the quality, quantity, and importance of both public facilities and green space.
- Section D: Visiting habits – contains questions assessing frequency and duration of visits to the Goods Line North (and how this compares to visits to the Goods Line South, if applicable).
- Section E: About you – contains five demographic questions.

The questionnaire was distributed by researchers to consenting participants at the Goods Line North, and was self-administered by participants to ensure responses were not influenced by the researcher's presence. A total of 201 surveys were completed by participants and analysed by researchers.

Responses to qualitative questions were coded in accordance with a coding scheme developed by the research team following an initial assessment of participant responses. The research team used SPSS Statistics software to assist with analysis.

2.2.3. Direct Observation

Direct observation of the Goods Line North involved taking time-lapse photos of the site from a set location at prescribed intervals over the course of two full days. In order to obtain an hourly count of visitors to the site, photos were taken every hour from 0800 to 1700, and the numbers of individuals sighted in the photos were counted.

In order to estimate duration of visits to the site, photos were taken every fifteen minutes during 'even' hours (e.g. photo at 0800 (even), 0815, 0830, 0845, 0900 (odd), 1000 (even), 1015, 1030, 1045, 1100, and so on). Consecutive photographs taken at fifteen-minute intervals were compared, and the duration of visits was estimated according the number of photographs in which the same individual appeared (Table 3).

Table 3 Method of estimating duration of visits from time-lapse photography analysis.

Number of consecutive photos containing the same individual	Estimated duration
One (e.g. 0830 only)	Less than 15 minutes ³
Two (e.g. 0830 and 0845)	More than 15 minutes
Three (e.g. 0830, 0845, and 0900)	More than 30 minutes
Four (e.g. 0800, 0815, 0830, and 0845)	More than 45 minutes
Five (e.g. 0800, 0815, 0830, 0845, and 0900)	More than 60 minutes

All photos were also assessed as to the activities undertaken by visitors.

2.2.4. Interviews

Semi structured interviews with local businesses were conducted as part of the evaluation. The focus of the interviews was to assess whether the redevelopment of the Goods Line had any perceived impact on the business. These interviews contribute to the assessment of economic change indicators in the evaluation framework.

2.3. Environmental Research

2.3.1. Air Quality Monitoring

Researchers from the UTS Science Faculty conducted air quality of monitoring of the Goods Line site to assess any in the change in air quality from increases in local green space.

Baseline sampling was conducted across four study sites for 16 months (Figure 4), from 4 October 2013 to 25 February 2015, to provide a dataset indicating the background air quality across the sample area. This involved a total of 59 sample events, with matched samples taken at sites likely to be influenced by increased green space and at reference sites. Initially site 1 and site 2 were to be compared to site 3 and 4 (Figure 4); however, additional vegetation expected to be planted at site 1 did not eventuate. Site 1 then became a third reference site, leaving only site 2 as a treatment site to which additional green space was established.

³ A limitation of this method is that the number of individuals estimated to have visited for less than fifteen minutes may be slightly overstated. This is because an individual who arrives at 0820 and stays until 0840 would have stayed for twenty minutes, but would only be captured by one photograph and thus assumed to have stayed for less than fifteen minutes. This limitation would also mean that estimates of visitors staying more than fifteen minutes may be slightly understated.

Figure 4 Sampling locations along the Goods Line and at a reference control site for the air quality study.



Establishment of green space was completed and the Goods Line North opened on 30 August 2015. To detect any initial change, intensive air sampling was conducted on 1, 2, and 3 September. Further sampling followed in February 2016, where twice-daily samples were taken on 15, 17, 19, 22, 26, and 28 February. This regime allowed comparison with samples taken at the same time of year but prior to the establishment of new areas of green space to detect any changes attributable to additional vegetation. Air samples were collected between 1100 and 1400 h on weekdays. The time between samplings ranged from 3 to 14 days.

For quality assurance, comparisons were made of air quality at other locations in Sydney coincident with sampling times used at the Goods Line. These data were downloaded from the Randwick, Rozelle and Earlwood monitoring sites, operated by the NSW Office of Environment and Heritage (OEH).

More information on the air quality research method, including a description of the equipment used and approach to statistical analysis, is available in the Goods Line air quality report provided by UTS Science at Appendix C.

2.3.2. Stormwater runoff

A stormwater runoff assessment was included in this research to determine whether the redevelopment of the Goods Line North would affect levels of runoff from the site.

Stormwater runoff, expressed as a percentage of total precipitation that is not absorbed by the Earth's surface within the site boundary, was calculated for before and after redevelopment of the Goods Line North. With reference to site plans provided by ASPECT Studios (the Goods Line architects), GIS software was used to construct polygons for selected surface types (asphalt, concrete, grass and gravel) for the before and after sites. These polygons were overlaid on Google Earth satellite imagery relating before redevelopment (2009) and after redevelopment (2016). Proportions of each surface type to total site area were calculated from the constructed polygons.

To estimate total run-off, the Rational Method was used, which is accurate for estimation of runoff from small drainages with a high proportion of impervious area (ODOT 2011). Run-off coefficients for each surface type were obtained from the literature (ODOT 2011), and aggregated, weighted by surface area, to derive a total site runoff coefficient for before and after redevelopment. The total site runoff coefficients were converted to a percentage value and compared to assess any change in stormwater runoff resulting from the redevelopment.

2.3.3. Biodiversity

The inclusion of green space within the redevelopment of the Goods Line North may also increase the biodiversity of the area. Under the advice of Birds Australia, a 25-minute bird survey was undertaken to assess the diversity of bird life at the Goods Line, as a potential indicator of biodiversity more generally. The bird survey of the Goods Line North was undertaken in April 2016.

3. Outputs

This section describes the outputs of the social and biophysical research focusing on the Goods Line North, categorised according to the research methods used. Discussion of the outputs in relation to the project's evaluation framework, with comparisons to the evaluation of the Goods Line South, is provided in the Outcomes section that follows.

3.1. Goods Line North social research – participant questionnaire

3.1.1. Section A: General attitudes

Table 4 provides the most frequent themes⁴ raised by participants when asked why they came to the Goods Line North. Participants were most likely to respond that they came for relaxation (30%), to eat lunch (26%), or to get outdoors (23%). Many responses also suggested participants came to the Goods Line North simply because it was convenient (22%). Only 13% of responses specifically mentioned that they came to the Goods Line North for green space.

Table 4 Summary of most frequent responses to Question A1.

Why do you come to this new end of the Goods Line?		
Coded response	Frequency	Percentage
Relax/break	59	30%
Eat	51	26%
Get outdoors	46	23%
Convenience	44	22%
Sitting	36	18%
To get somewhere else	31	16%
Aesthetics	29	15%
Green space	25	13%

Table 5 shows the most frequent themes raised by participants when asked what they like most about the Goods Line North. Green space was the most common theme (39%), followed by the available seating (37%), and the general aesthetics (36%).

⁴ To simplify the reporting of results in Section 3.1.1, responses with a frequency greater than twenty are considered the 'most frequent' responses and are provided in the tables. A full breakdown of responses for Section A of the questionnaire, and the coding scheme used to group responses, is given in Appendix D.

Table 5 Summary of most frequent responses to Question A2.

What do you like most about this new end of the Goods Line (if anything?)		
Coded response	Frequency	Percentage
Green space	77	39%
Seating	73	37%
Aesthetics	71	36%
Urban escape	51	26%
Outdoor space (other than green space)	45	23%
Social	39	20%
Convenience	27	14%

Table 6 details the most frequent responses as to what site visitors disliked about the Goods Line North. It was most common for participants not to provide a response (38%), which likely indicates a general satisfaction with the site. When participants did identify something they disliked, it usually related to (a lack of) amenities (21%) or that it felt too sunny or lacked shade (11%).

Table 6 Summary of most frequent responses to Question A3.

What do you dislike about this new end of the Goods Line (if anything?)		
Coded response	Frequency	Percentage
Blank (no response)	76	38%
Amenities	42	21%
Too much sun/heat	22	11%

Table 7 shows the most frequent themes raised by participants when asked why they choose to come to the Goods Line North instead of other outdoor places. The majority of participants say they chose the site because it was convenient for them (54%). Over a quarter of participants suggested the site provided an escape from the urban environment (28%), and another quarter of participants said they chose the site for its aesthetics (25%). Only 6% of responses mentioned something related to green space when describing why they chose the site.

Table 7 Summary of most frequent responses to Question A4.

Why do/would you choose to come here to the Goods Line instead of other outdoor places?		
Coded response	Frequency	Percentage
Accessible/convenient	106	54%
Urban escape	55	28%
Aesthetics	48	25%
Outdoors (other than green space)	23	12%

Table 8 provides the most frequent suggestions from participants as to how the Goods Line North could be improved. The most common response was to express satisfaction or leave the question blank (42%), which likely indicates an unexpressed satisfaction with the site. Some participants felt there could be more shade or shelter either in the form of additional trees or a physical structure (14%). Others wished for additional amenities (13%), while others wished for the site to contain attractions or diversions such as buskers, market stalls, or other programming (11%).

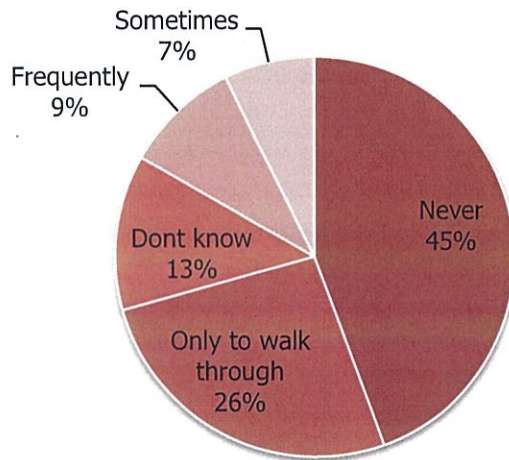
Table 8 Summary of most frequent responses to Question A5.

Are there any changes that could be made to the Goods Line that would improve your experience or make you visit more often?		
Coded response	Frequency	Percentage
Satisfied (or blank)	93	42%
Shelter/shade	30	14%
Amenities (other than shade provision)	28	13%
More attractions	24	11%

3.1.2. Section B: Previous use

Figure 5 describes the percentage of participants who had (or had not) visited the Goods Line South. Nearly half of all participants responded that they had never visited the Goods Line South (45%). Around a quarter of participants responded that they only used the Goods Line South as a thoroughfare (26%).

Figure 5 Frequency of participant visits to the Goods Line South.



Those who had visited the Goods Line South were asked to answer some questions seeking a comparison of the Goods Line North with the Goods Line South. Table 9 shows themes raised by participants in consideration of the changes in the Goods Line since the opening of the Goods Line North. The most common sentiment was that there were more people (37%). Improved amenities or activity options (19%), aesthetics (19%), and green space (12%), were also common responses.

Table 9 Summary of responses to Question B2.

What have you noticed about how the Goods Line has changed since the opening of this new end?		
Coded response	Frequency	Per cent
More people	37	38%
Improved amenities/activity options	19	19%
Positive aesthetics or feel	19	19%
Green space	12	12%
All others	11	11%

Table 10 gives a breakdown of whether participants considered their experience on the Goods Line has improved or worsened since the opening of the Goods Line North. The vast majority of participants responded that their experience had improved (89%).

Table 10 Summary of responses to Question B3.

Has your experience in the Goods Line changed since the opening of this new end?		
Option	Frequency	Per cent
Yes – improved	79	89%
No – unchanged	10	11%
Yes – worsened	0	0%

Table 11 details the most common themes raised by participants when considering why their experience has improved since the opening of the Goods Line North. The improvement was most often attributed to the amenities and associated opportunities for activity/interaction (25%). Other common responses related to improved aesthetics (22%) and the additional green space (17%).

Table 11 Summary of responses to Question B4.

If you answered 'Improved' at B3 above, what is/are the main reason(s) for this improvement in your experience?		
Coded response	Frequency	Per cent
Amenities/activities	31	25%
Aesthetics/feel	27	22%
Green space	21	17%
Access/walkability/convenience	15	12%
Outdoors/openness	14	11%
All others combined	14	11%

3.1.3. Section C: Sentiments

Figure 6 shows the frequency of specified activities on the Goods Line North in which participants engaged. Participants responded that they most often use the Goods Line North for passive recreation such as taking a break, relaxing, socializing, to sit in the grass, or to find solitude. Many participants also responded that they used the Goods Line North as a thoroughfare. More active or professional uses of the Goods Line North such as exercising or working/studying were less common.⁵

⁵ It is noted that the method of questionnaire dissemination may lead to a bias in responses toward those who were using the Goods Line North for passive recreation (i.e. those who were using the site as a place to run were less likely to stop and participate in the research by completing a questionnaire).

Figure 6 Frequencies of undertaking specified activities in the Goods Line North (Question C1A).

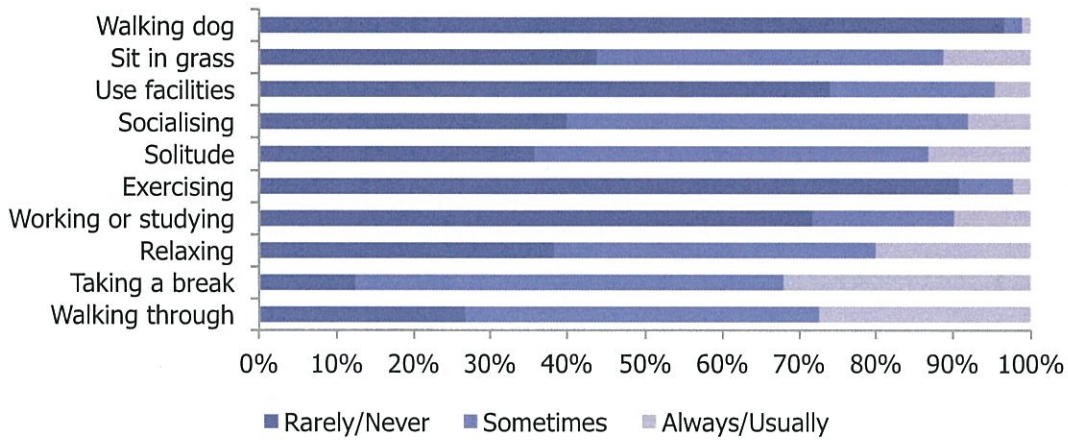


Figure 7 details whether participants engaged in specified activities more, or less, in the Goods Line North, when compared with their experience in the Goods Line South. Over half of participants suggested they use the Goods Line North more than the Goods Line South for passive recreation such as taking a break, relaxing, solitude, and socialising. Less than ten per cent of participants suggested they used the Goods Line North less than the Goods Line South for any of the specified activities.

Figure 7 Frequency of engaging in specified activities in Goods Line North, compared with Goods Line South (Question C1B).

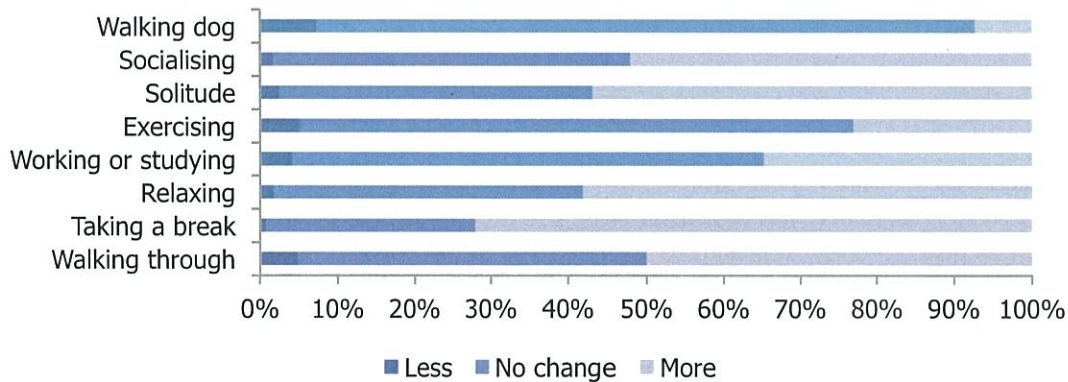


Table 12 summarises whether participants work or study on the Goods Line North alone or with others. Participants who responded to this question tended to prefer working or studying alone (47% more often or always alone). Slightly more than one quarter of participants (27%) indicated that they always or more often work or study with others.

Table 12 Summary of responses to Question C2.

Do you usually [work or study] alone or with others?		
Option	Frequency⁶	Per cent
Always alone	20	19%
More often alone	30	28%
Equally alone and with others	28	26%
More often with others	22	20%
Always with others	8	7%

Figure 8 details the extent of participant agreement with certain statements about the Goods Line North’s appeal. Over ninety percent of participants agreed that the Goods Line North was visually appealing, that they liked its green space and built environment, that they felt safe, and that they enjoyed the space overall. A majority of participants also agreed that there was a sense of community in the Goods Line North, although this was lower than the proportion that agreed with the other statements.

Figure 8 Extent of participant agreement with specified statements about the Goods Line North (Question C3A).

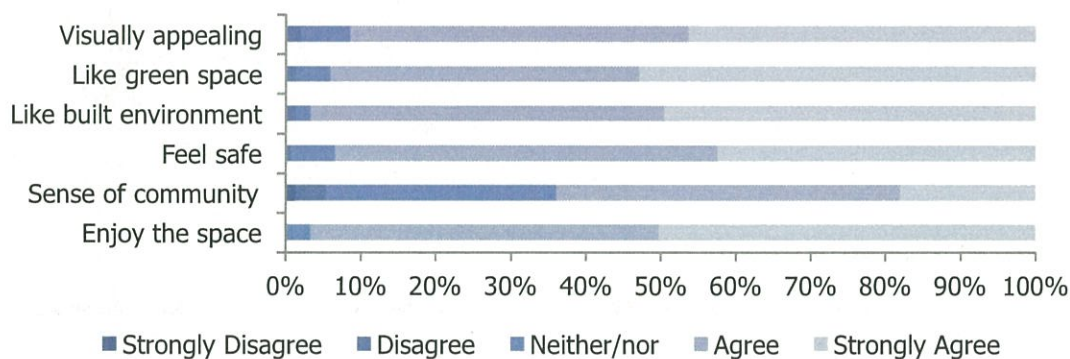
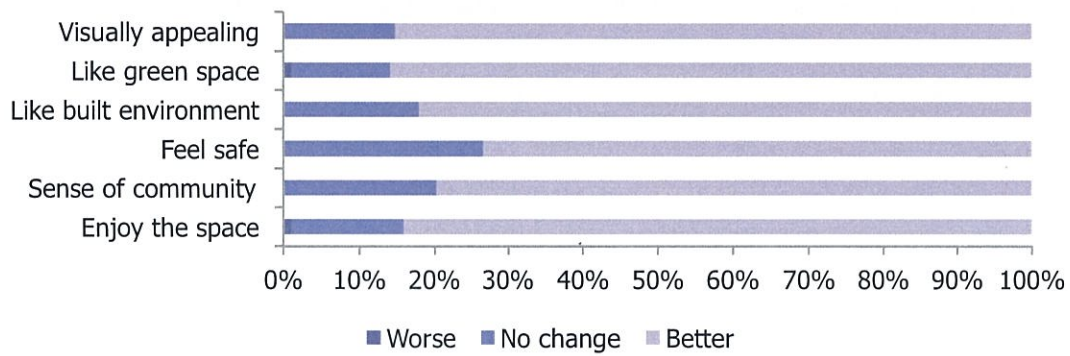


Figure 9 describes whether participants felt the Goods Line North outperformed the Goods Line South with regard to the aforementioned statements about the site’s appeal. Nearly three-quarters of participants familiar with the Goods Line South felt that the Goods Line North was more visually appealing, felt safer, had stronger sense of community, was an improved green space and built environment, and was a more enjoyable space. Participants almost never felt that the Goods Line North performed worse than the Goods Line South on any of these sentiments.

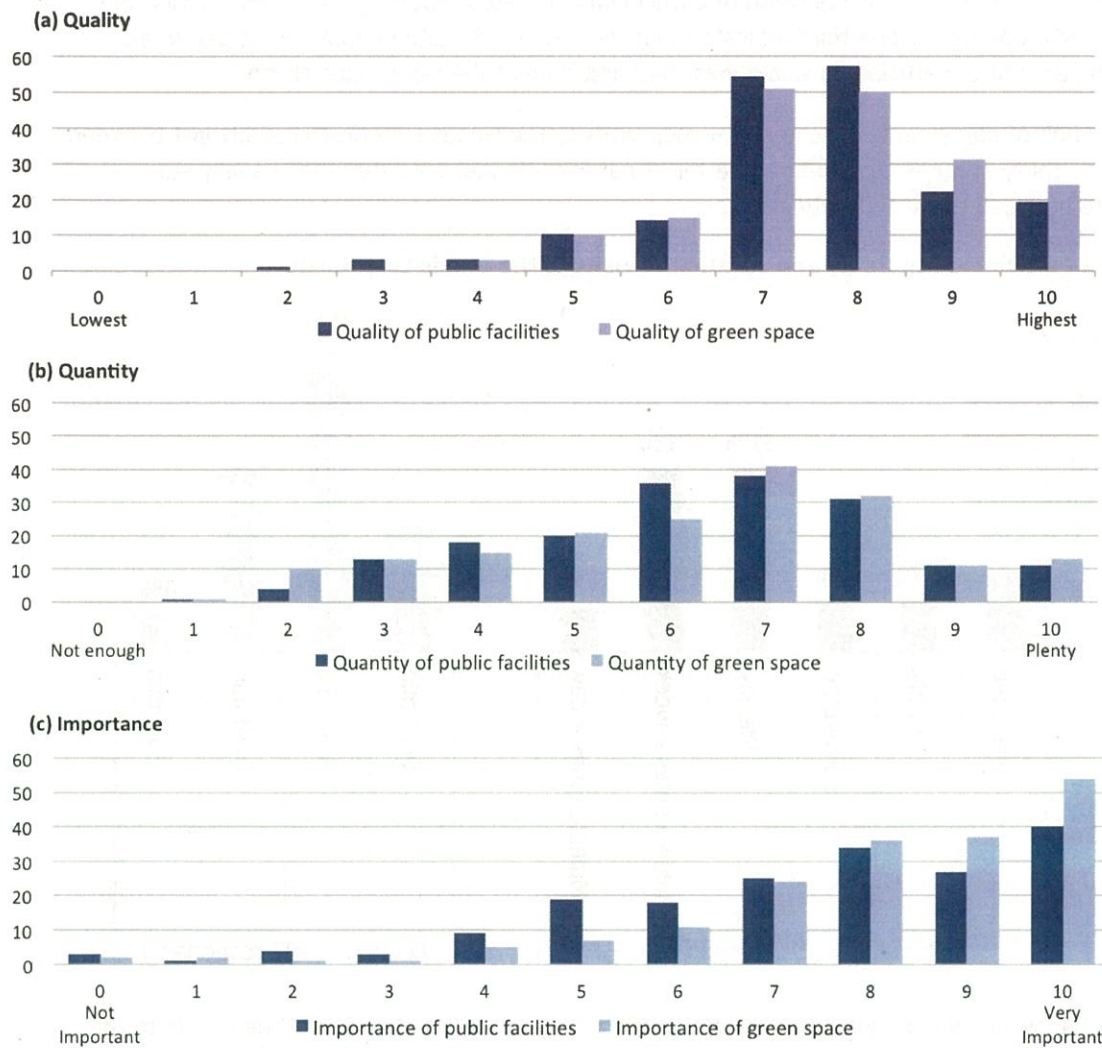
⁶ Question C2 was meant to be answered only by those participants who indicated that they ‘Always/Usually’ or ‘Sometimes’ worked or studied in the Goods Line North (Question C1A; Figure 6). Forty-nine participants indicated that they ‘Always/Usually’ or ‘Sometimes’ work or study in the Goods Line North, however 108 participants went on to indicate whether they work or study alone or with others on the Goods Line North (Question C2). Given that Question C2 was answered by a broader cohort than intended (i.e. over half of the responses may have come from participants who previously indicated they rarely or never work or study at the Goods Line North), the results are presented here but not interpreted further in this report.

Figure 9 Participant sentiment as to whether the Goods Line North was better or worse than the Goods Line South with regard to specified qualities (Question C3B).



Questionnaire participants were asked to rate the quality, quantity, and importance of the public facilities and the green space in the Goods Line North on a scale of 0 (low) to 10 (high). Figure 10 shows the frequency of participant ratings for quality, quantity, and importance.

Figure 10 Frequency of ratings given to (a) quality, (b) quantity, and (c) importance of public facilities and green space at the Goods Line North from questionnaire participants.



Participant attitudes about the quality of public facilities and green space were generally favourable, with the majority of ratings being 7 or higher. Participants also felt that public facilities and green space were important, with green space considered to be slightly more important than public facilities.

Participant attitudes about the quantity of public facilities and green space were more variable, which suggests a greater range of opinions as to the sufficiency of green space and public facilities at the Goods Line North.

3.1.4. Section D: Visiting habits

Figure 11 details how regularly participants indicated they visited the Goods Line North, and the duration of their visits. Nearly one-third of participants indicated that they visited the Goods Line North weekly, and nearly one-third indicated that they visited the site multiple times per week. Fourteen per cent of participants said it was their first time at the Goods Line North.

Just over half of participants indicated that their visits to the Goods Line North usually last between fifteen and thirty minutes. Just over a quarter of participants indicated that they usually stay anywhere between thirty and sixty minutes.

Figure 11 Participant regularity and duration of visits to the Goods Line North.

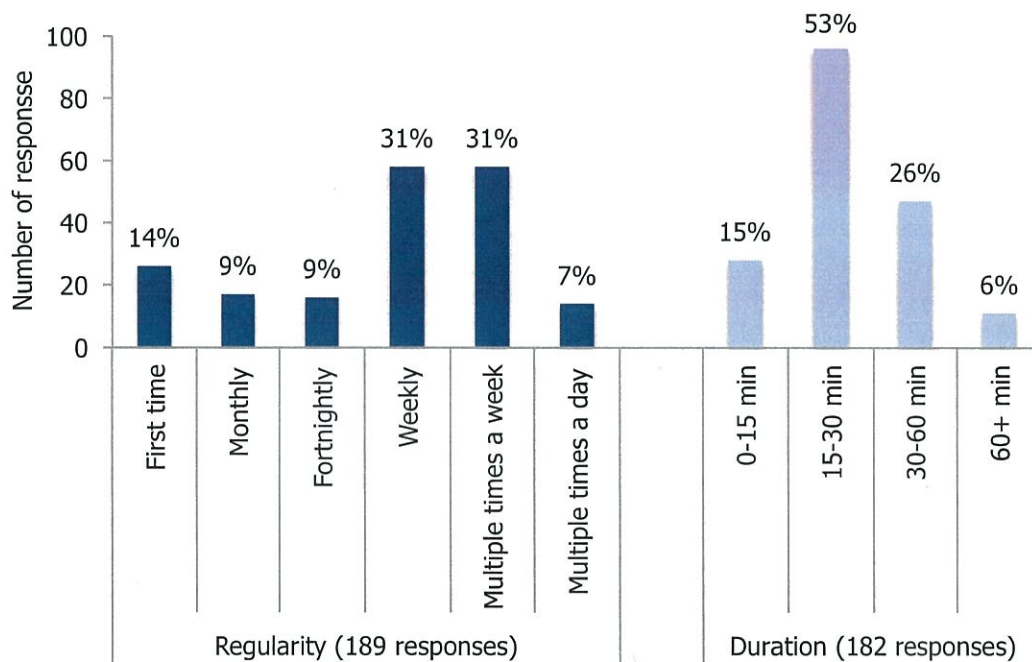
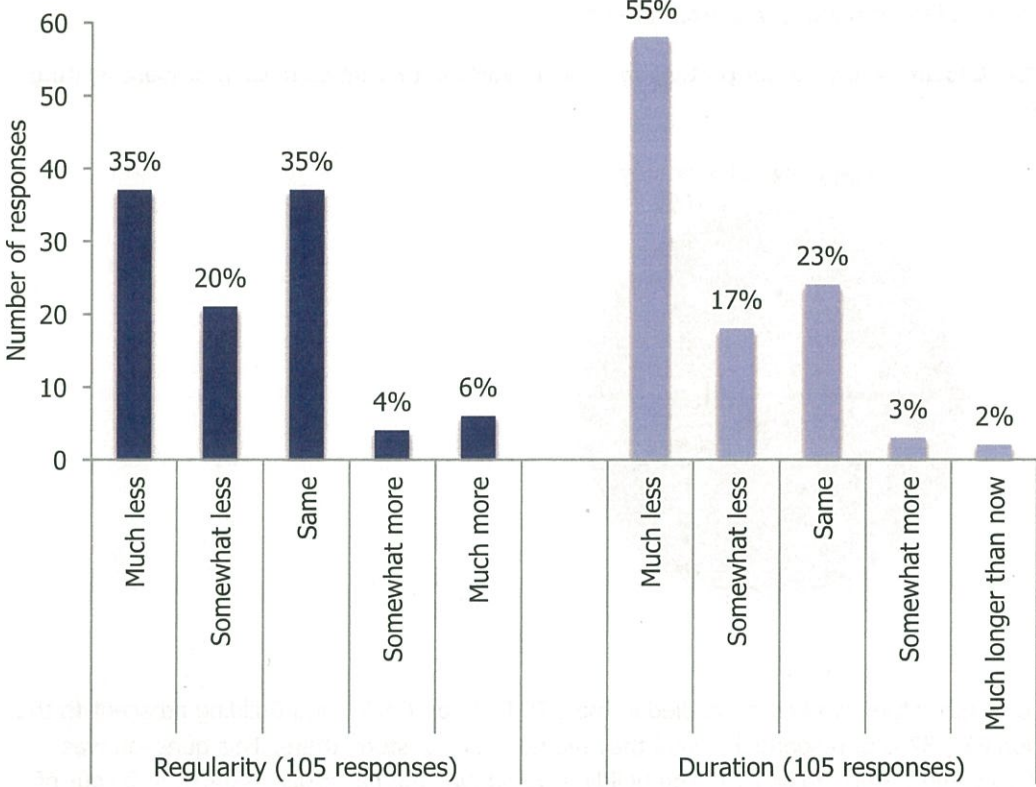


Figure 12 shows how participants have compared the regularity and duration of their visits to the Goods Line North with their visits to the Goods Line South. Over half of participants said they visited the Goods Line South less regularly (55% much less and somewhat less combined). Nearly three-quarters of participants said they spent less time in the Goods Line South (72% much less and somewhat less combined) when compared with their experience in Goods Line North.

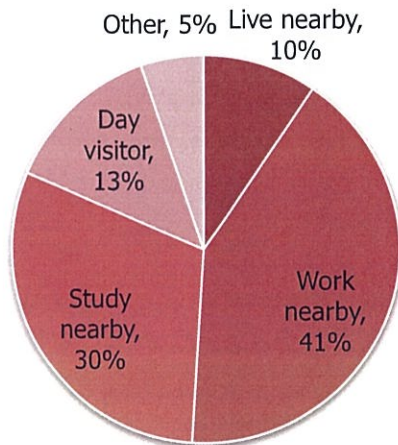
Figure 12 Regularity and duration of participant visits to the Goods Line South, compared with the Goods Line North.



3.1.5. Section E: About you

Figure 13 indicates that the vast majority of participants lived, worked, and/or studied in the local area (defined as a fifteen-minute walk from the site).

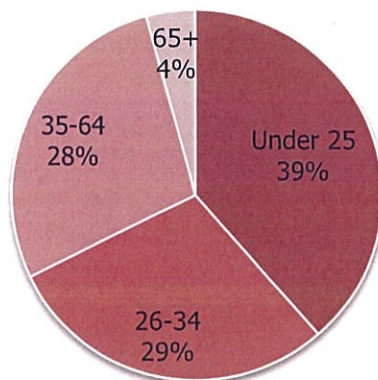
Figure 13 Breakdown as to whether participants lived, worked, or studied locally, or were visiting for the day.



When asked whether they worked or studied in the UTS Dr Chau Chak Wing Building adjacent to the site (Question E2), 82% of respondents said they did not work or study there. This question was used to assess whether the proximity of the building would bias the participant sample in favour of building occupants. Given that over four out of five participants did not work or study in the building, the proximity of the building to the Goods Line North is not thought to have any particular bias on the questionnaire results.

Nearly all participants were under the age of 65, with 39% of participants being under 25 (Figure 14). This reflects the fact that the majority of visitors to the Goods Line North work or study nearby.

Figure 14 Age breakdown of participants.



Slightly more males (97) than females (91) participated in the research, while one participant reported an 'Other' gender identity (twelve participants did not indicate any gender identity).

When asked what language they speak at home, a large majority of participants (87%) indicated English, while thirteen per cent indicated 'Other'.

3.1.6. Direct observation

Direct observation was conducted on the Goods Line North over two days – Thursday 21 April 2016 and Tuesday 3 May 2016. Figure 15 shows the hourly counts of visitors to the site on both days, and an average of the two sampling days. Usage of the Goods Line North was highest from 1100 to 1500, with average visitation peaking around 1300. Visitors were fewer in the morning and in the late afternoon. This pattern of visitation is consistent with the site’s popularity as a location to have lunch outdoors or otherwise have a break from work or study obligations.

Figure 15 Hourly counts of visitors to the Goods Line North.

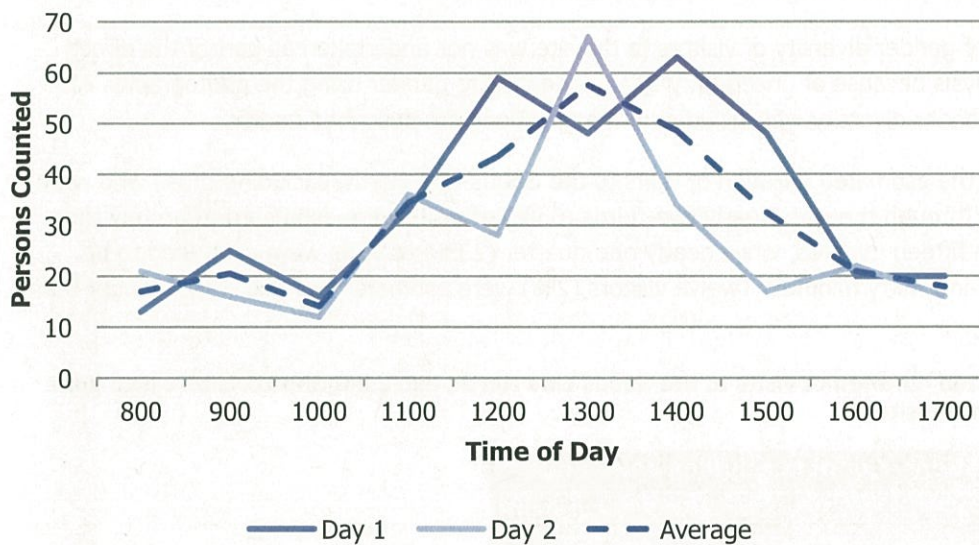


Table 13 describes the activities undertaken by visitors to the Goods Line North, as assessed using the time-lapse photographs. Nearly half of all individuals were at the Goods Line North because they were walking to a nearby attraction, such as UTS or the Powerhouse Museum, underscoring the important role of the site in enhancing the connectivity of the area. Other popular activities were sitting or laying on benches or the amphitheatre steps, which corroborates the site’s utility for taking a break or eating lunch.

Table 13 Summary of activities undertaken on the Goods Line North by visitors.

Activity	Count		
	21 April	3 May	Total
Walking through	444	222	666
Standing, sitting, or laying on a bench or seat	96	123	219
Standing, sitting, or laying on the amphitheatre steps	37	64	101
Standing or sitting at the communal table	42	47	89
Interacting with the sand feature	50	21	71
Standing elsewhere on the Goods Line North	26	42	68

Standing, sitting, or laying in the grass	41	25	66
Interacting with the table tennis or outdoor gym infrastructure	24	10	34
Any other activity ⁷	13	13	26

Analysis of the time-lapse photography revealed 108 children on 21 April, compared with 15 children observed on 3 May. The popularity of the site for children on 21 April is likely because 21 April fell within the NSW school holiday period in 2016. The Powerhouse Museum held a program of activities during the school holiday period, and many children were on the Goods Line North with parents or carers because they were walking to or from the museum. Many children stopped to interact with the sand feature while on site, which appears to be reflected in the popularity of that activity on 21 April as compared with 3 May. The school holiday period may also explain why more people overall were observed on 21 April when compared with 3 May.

An assessment of gender diversity of visitors to the site was not undertaken as part of the direct observation analysis because of uncertainty around identifying gender using the photographs. An assessment of gender diversity was included in the questionnaire described earlier.

Table 14 details the estimated duration of visits to the Goods Line North, excluding those who were only commuting through the site. Nearly two-thirds (63%) of visits were estimated to occupy the site for less than fifteen minutes, while nearly one-quarter (23%) of visits were estimated to be between fifteen and thirty minutes. Twelve visitors (2%) were estimated to have stayed longer than one hour.

Table 14 Estimated duration of visits to the Goods Line North, excluding those visitors who were walking through the site.

Estimated duration	Count (excluding commuters)	
Less than 15 minutes	355	63%
At least 15 minutes	130	23%
At least 30 minutes	48	8%
At least 45 minutes	21	4%
At least 60 minutes	12	2%

Table 15 displays the results of an assessment of the time-lapse photography as to whether visitors to the Goods Line North visited alone, in a pair, or as a group of three or more. This assessment revealed that the site was slightly more popular to visit with one or more companions than to visit alone. When excluding those who were only commuting through the site, two thirds of visitors came to the site with one or more companions.

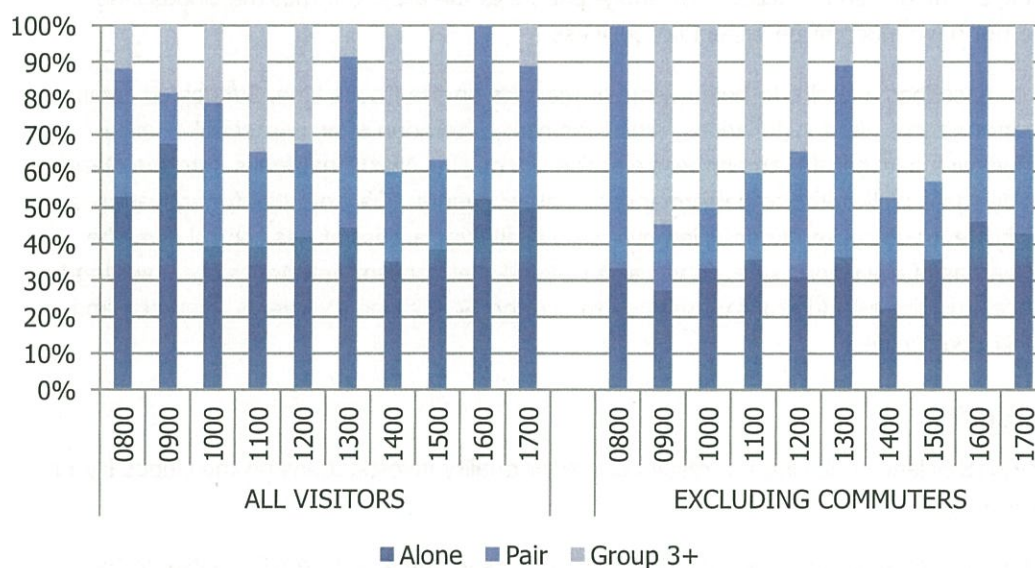
⁷ Other activities include cycling, setting up a film set, tai chi, skateboarding, or undertaking maintenance work.

Table 15 Numbers of visitors to the Goods Line North who visited alone, in a pair, or in a group of three or more.

	All visitors		Excluding commuters		Commuters only	
Alone	271	44%	118	33%	153	59%
In a Pair	197	32%	132	37%	65	25%
Group of 3+	147	24%	107	30%	40	16%

Figure 16 gives an hourly breakdown of visitation alone, as a pair, or in a group of three or more. Persons visiting alone exceed half of all visitors at 0800, 0900, 1600, and 1700 – consistent with both the site’s utility for commuters and the relatively lower numbers of people visiting the site to take a break or eat lunch during those hours. Exclusion of commuters lowered the percentage of lone visitors at each hour, however the percentage of lone visitors remained above thirty per cent for most hourly snapshots. This mix of lone visitors as well as those visiting with others is consistent with questionnaire results suggesting the site was valued for both social interaction as well as for solitude.

Figure 16 Hourly breakdown of visitor numbers to the Goods Line North, based on whether they visited alone, in a pair, or in a group of three or more.



3.2. Interviews

In 2014, prior to the completion of the Goods Line North, a selection of five small businesses were asked to participate in an in-depth interview due to their close proximity to the site and high probability of being impacted by the redevelopment.

Common themes emerged for most of the interviewees who had primarily selected the location of their business due to cheaper rent, a strong student population and being close to a pedestrian thoroughfare.

Positive and negative attributes were associated with the local area, including the Goods Line.

Considering the local area as a whole, negative perceptions outweighed the positive with descriptions such as 'bleak', 'dilapidated', 'parking issues', 'dodgy' and 'unattractive' being common. Despite negative sentiments about the appeal of the local area, only the inability to park conveniently was perceived to have an impact on some businesses. While the lack of atmosphere and perceived unattractiveness of the area were conveyed by all interviewees, the current pedestrian thoroughfare was seen to be beneficial to the commercial success of the area.

Interviewees expressed skepticism as well as optimism about the benefits the Goods Line redevelopment will bring to their businesses. While one small business owner felt the Goods Line would not impact their sales in any way, the resounding hope was that 'more people will mean more business'. Although the potential success of the Goods Line created apprehension in some interviewees that rents would increase and impact their business negatively, on the whole the small business interviewees were hopeful that their sales and profits would increase.

Four of the five businesses were interviewed again in 2016, following the opening of the Goods Line North. Interviewees generally felt that the completion of the Goods Line North had neither a positive nor negative impact on their business. One business owner mentioned that the opening of the site had improved connectivity to Chinatown, but that this alone was unlikely to change the existing preferences of local workers and residents as to where they want to eat, drink, and socialise. Another interviewee suggested that the thoroughfare brings in pedestrian activity and that the Dr Chau Chak Wing Building is an attraction that brings people to the area, but that the Goods Line North itself did not have much of an impact on business.

One interviewee described a desire to hold events or markets on the Goods Line. Suggested ideas were drama performances, light installations, music festivals, afternoon teas, basketball or other sport. The interviewee felt that the amphitheatre at the Goods Line North that looks onto the Mary Ann Street cul de sac is well suited to performances or other events. This potential for activation is made difficult, however, because of confusion over who is allowed access or has control over the use of different areas of the Goods Line. It was also claimed that consent authorities are unwilling to partner with local businesses and grant permission to use the Goods Line for events, markets, and other activation opportunities.

3.3. Air Quality

A full report by UTS Science detailing the results of the air quality investigations on the Goods Line is given at Appendix C.

In summary, the investigation found no significant differences in ambient air quality between the Goods Line North and adjacent reference control sites. However, sporadic, high concentrations of some air pollutants appear to have been mitigated after opening of the Goods Line North. Specifically, average concentrations of nitrogen dioxide were lower at the Goods Line North on days hotter than 27°C. This result indicates that the inclusion of urban green space may be producing a quantifiable reduction in local nitrogen dioxide, and that this mitigating effect may be enhanced with additional vegetation or with growth of existing vegetation.

3.4. Stormwater runoff

Table 16 provides the details of the stormwater runoff analysis. The analysis revealed a near ten per cent decrease in runoff following the redevelopment, based on an assessment of site surface types prior to (2009) and after (2016) the redevelopment. Aerial imagery showing proportions of site

surface types before and after redevelopment is provided at Appendix E.

Table 16 Results of stormwater runoff analysis for the Goods Line North redevelopment.

Surface type	Before construction (2009)		After construction (2016)	
	Site area (%)	Runoff (%)	Surface area (%)	Runoff (%)
Asphalt	54.7	90	6.9	90
Concrete	8.4	85	51.8	85
Grass	0	25	11.8	25
Gravel	36.9	85	29.6	85
Whole site		88		78

4. Outcomes and Discussion

Implications of the research results are discussed here with reference to the evaluation framework described at Section 2.1. Results from the 2014 evaluation of the Goods Line South (presented in full at Appendix A) are referenced in this section when appropriate for making a comparison with the Goods Line North or when discussing the entirety of the Goods Line.

4.1. *Social attributes*

4.1.1. Visitation of space

Expected outcomes in the evaluation framework relating to **visitation of space** include:

- An increase in the number of people using the site
- People stay in the space for longer
- A diversity of people are using the space.

Direct observation and questionnaires revealed that the entirety of the Goods Line is a well-used space. Visitors who were familiar with the entirety of the site felt that there were more people on the Goods Line since the opening of the Goods Line North.

Visitation levels for both the Goods Line North and the Goods Line South are at their highest between the hours of 1100 to 1500, when the site is popular for having lunch or taking a break from work or study. The Goods Line South is slightly more popular in the morning and late afternoon compared with the Goods Line North, likely a result of the Goods Line South's closer proximity to Central Station, the ABC, and other office buildings.

Visitors to the Goods Line North are likely to spend more time in the space, compared with visitors to the Goods Line South. Participant questionnaires revealed that 32% of visitors remain at the Goods Line North for thirty minutes or more, compared with only 11% of visitors to the Goods Line South. A majority of visitors to the Goods Line North also said they visit the Goods Line North much more regularly than the Goods Line South, and that they spend more time per visit in the Goods Line North compared with the Goods Line South. Therefore, it is likely that the green space and public amenities associated with the Goods Line North have resulted in people staying in the space for longer periods.

The Goods Line North was visited by roughly equal percentages of males and females. The site was also popular with children with visitation levels demonstrably higher during the school holiday period. Questionnaire results suggested that there were relatively few visitors over the age of 65. While this may be a result of the Goods Line North's popularity with students and people of working-age, further research may be warranted to understand whether the site could be made more attractive or accessible for the elderly.

4.1.2. Uses and activities

Expected outcomes in the evaluation framework relating to **uses and activities** include:

- A broad range of activities is undertaken in the space.

The Goods Line is heavily used as a pedestrian corridor, underscoring its importance for providing a

safe and attractive commute between destinations in the Ultimo/Haymarket area. At the same time, both direct observation and participant questionnaires revealed that the Goods Line North is used for a wide range of activities other than commuting. The most popular activities relate to passive recreation such as respite from work or study, eating lunch, relaxing, socializing, sitting in the grass, or finding solitude. Activities such as exercising were mentioned by participants, and observed by the research team, but were less popular.

Users of the site suggested that the varied amenities provided in the Goods Line North were a major attraction and enabled a wide range of activities. Participants most commonly used the many benches, the amphitheatre, the communal table, and the grassy areas to find some time alone or socialise with peers. The sand feature was popular with children, as many families or groups stopped here as they traveled from Central Station to the Powerhouse Museum. The table tennis and outdoor gym facilities were also used, but were less popular than the amenities designed for passive recreation or collaborative working/studying. An affinity for amenities in public places aligns with the research of Fried (2000), who found that physical features such as the presence of amenities facilitate social interactions which, in turn, contribute to place attachment.

While it may be said that the Goods Line North meets the outcome of supporting a broad range of activities, the evaluation has revealed the importance of harmonising green space and public amenities to deliver a positive and diverse visitor experience.

A selection of visitors surveyed wished for more activity on the Goods Line in the form of events, markets, performances, or even buskers. Interviews with local businesses confirmed the desire to hold events or markets on the Goods Line, particularly the Goods Line North and its amphitheatre area. However, there is confusion as to the process for, and likelihood of, having such programming approved by the relevant consent authority. Overcoming these barriers to enable programming to activate the Goods Line North would further broaden the range of activities undertaken in the space.

4.1.3. Health and wellbeing

Expected outcomes relating to **health and wellbeing** include:

- The site encourages physical activity
- The site encourages sedentary activity and relaxation
- The space encouraged increased social interactions

There is evidence to suggest that the Goods Line North encourages and enables an increase in sedentary activity and relaxation. On the other hand, while selected aspects of the site encourage physical activity, this was far less common. Although direct observation did reveal a small number of joggers, cyclists, tai chi practitioners, and individuals using the outdoor gym facilities, the Goods Line North is most popular as a site for passive recreation rather than active recreation. Relaxing, taking a break, sitting, and simply being outdoors were some of the most popular reasons for people to visit the Goods Line North. A majority of visitors familiar with the entirety of the Goods Line suggested they use the Goods Line North more than they used the Goods Line South for taking a break, relaxing, solitude, and socializing.

There is also evidence to suggest that the Goods Line North encourages social interactions, as two-thirds of 'non-commuters' visited the site in groups of two or more people. However, one-third of 'non-commuters' visited the site alone, which suggests that the site enables both social interaction and solitude. Evidence to corroborate this mix of uses is seen in the roughly equal amount of

questionnaire participants who said they used the site for 'Socialising' and for 'Solitude'. When considering all visitors, groups of two or more were more common in the middle of the day, while lone visitors were more common in the morning and late afternoon. However, the proportion of lone visitors was never less than 30%, suggesting that the Goods Line North is a versatile space that enables social interaction or solitude throughout the day.

Therefore, while the Goods Line North did encourage social interaction, it was sufficiently flexible to allow for a range of experiences catering to a diversity of user needs.

4.1.4. Place attachment

Expected outcomes relating to **place attachment** include:

- An increased sense of community attachment in the space
- An increased affinity towards the physical space
- An increased affinity towards the natural environment space
- An increased perception of safety within the space.

A majority of questionnaire participants agreed with the statement that there is a sense of community at the Goods Line North, and that the sense of community is stronger than in the Goods Line South. Community attachment may also be inferred by the high number of participants who said they visit the Goods Line North because it is near their work, their university, or is otherwise convenient. This high level of usage by local workers, students, and residents suggests that the Goods Line North has been a welcome contribution to the lives of those who regularly spend time in the area (i.e. the local community). The social ties between work or study colleagues, such as those in the Goods Line local community, are a form of social attachment (Riger & Lavrakas 1981). Combining this social attachment with an emerging attachment to the Goods Line North may be described as a combined physical-social place attachment (Mesch & Manor 1998; Uzzell et al. 2002).

The site is well used as both a meeting place and a respite space for the local community, while also serving as an attraction for a small number of 'tourists' visiting the Powerhouse Museum or the Dr Chau Chak Wing Building. Given the popularity of the space for locals and its tourist potential, the staging of events or markets (as suggested by local businesses and some questionnaire participants) may further expand the appeal of the Goods Line to a community broader than the immediate workers and students.

Visitors also reported a high level of affinity for the physical and natural space in the Goods Line North, and felt that the green space and built environment are an improvement to what exists at the Goods Line South. The quality and importance of the green space and public amenities were rated highly, and in many cases users felt there could have been more green space and public amenities at the site. These results suggest not only an affinity toward both the physical and natural environment, but also a recognition that the visitor experience is dependent on the availability of urban green space and physical facilities that support public enjoyment of the space (e.g. seating).

The green space and the available public amenities were also mentioned frequently when participants explained why the Goods Line North has delivered an improved experience when compared with Goods Line South. An affinity for amenities in public spaces was shown to contribute to place attachment (Fried 2000) and was discussed above. With regard to green space, participants valued the trees between the Goods Line North and Darling Drive, and the canopy provided by the trees. It is interesting to note that although participants showed an affinity for the tree canopy along

the Goods Line North, the trees themselves existed prior to the redevelopment. Therefore, while the Goods Line North did not provide additional trees as such, it did provide the benches, lawns, tables, and other amenities that unlocked the space below the trees and enabled visitors to experience benefits they provided in the form of shade, access to nature, and bird life. The Goods Line North was thus able to enhance the value of an existing green space asset – a dense tree canopy rare in inner city areas – by enabling access to the asset that had not existed previously. While participants desired more trees to provide further shade on sunny, warm days, further research is required to investigate whether this desire remains in the winter months when visitors may seek sun exposure on cooler days.

Participants overwhelmingly agreed that the Goods Line North felt safe and over three-quarters of participants were of the opinion that the Goods Line North performed better with regard to perceptions of safety when compared with the Goods Line South.

4.2. Environmental attributes

4.2.1. Air quality

The expected outcome relating to **air quality** is an improvement at the site.

While the air quality investigation undertaken as part of this research did not determine that the Goods Line North redevelopment contributed to any significant difference in ambient air quality, the study results pointed to potential mitigation of high concentrations of some air pollutants on hot days. Further sampling in the future would be required to enhance the confidence that the Goods Line North is contributing to improved air quality.

That the redevelopment did not lead to a strong improvement in air quality is likely to be related to the fact that only around one-third of the site was converted to green space, and that this green space is predominantly grass. Urban green spaces linked with improvements in air quality often have a more complex assemblage of vegetation types such as trees, shrubs, and grasses, and air quality improvements associated with vegetation generally increase with the amount of leaf area (Escobedo et al. 2011). Grass areas alone in urban environments may be inferior to large trees and shrubs when it comes to improvements in air quality (Currie & Bass 2008).

4.2.2. Stormwater runoff

The expected outcome is a reduction in **stormwater** runoff from the site.

The stormwater runoff analysis revealed a ten per cent decrease in runoff from the site after the redevelopment of the Goods Line North. The decrease in runoff is largely attributable to the nearly 12 per cent increase in grassed area because of the redevelopment. While the majority of the site remains impervious, the small increase in grassed area has resulted in a minor reduction (improvement) in volumes of storm water runoff when compared to the site conditions before the redevelopment.

Green space such as tree pits and ground vegetation have been shown to reduce stormwater runoff, which lessens stress on local stormwater systems and retains water in local areas that can support vegetation growth (Armson et al. 2013). Modelling suggests that the Goods Line North is reducing stormwater runoff which is likely to be benefiting local stormwater systems. It is likely that the inclusion of more green space either at the Goods Line or its immediate surroundings would provide

further benefits.

4.2.3. Biodiversity

The expected outcome is an increase in **biodiversity** on the site.

A bird survey on the Goods Line North was conducted on 13 May 2016. The survey located six different Noisy Miners in the trees at various intervals. Comparing this result with the lone Rock Dove (feral pigeon) found in the 2014 survey of the Goods Line South suggests that the redevelopment cannot be linked to change in biodiversity at this time or without more intensive biodiversity survey methods.

The redevelopment's lack of impact on biodiversity may be related to the relatively small amount and simple type of green space included in the redevelopment (i.e. predominantly grass), as discussed above when considering a lack of impact on air quality. Enhanced biodiversity at small urban scales requires increasing the coverage and complexity of vegetation (Ely & Pitman 2013) with the inclusion of trees the most important variable for enhancing bird species diversity (Goldstein et al. 1986; Sandström et al. 2006; Evans et al. 2009). No additional trees were provided by the redevelopment of the Goods Line North and it is unsurprising that only Noisy Miners were observed during the bird survey, and that they were found in the tree canopy that existed prior to the redevelopment.

4.3. Economic attributes

Expected outcomes relating to **new businesses** and **existing businesses** include:

- Increased activity with new businesses
- Increased activity with existing businesses.

Direct observation and interviews did not discover any new businesses on the Goods Line North, nor was there evidence to suggest that the redevelopment contributed to increased business activity with existing businesses in the area. However, business activity may lag site usage and it may take some time before business owners detect a measurable change. Similar sites at nearby locations have seen a marked upsurge in business activity through precinct scale renewal (e.g. at Chippendale). More intensive efforts at site activation, through local events, markets, or other programming on the Goods Line may be needed to enhance economic activity on the Goods Line itself, and may attract additional visitors to the site with flow on impacts to economic activity for businesses in the local area.

5. Evaluation

Greening the Goods Line was guided by research questions collaboratively developed by the research team and Hort Innovation. These research questions were:

- a) What are the social and biophysical changes that have resulted from the redevelopment of the Goods Line into public open space?
- b) To what extent are any social and biophysical changes related to increases in green space?
- c) Which are the key evaluation criteria that should be applied to open space redevelopments that include green space to determine an accurate measurement of change?

To investigate these questions, the researchers used participant questionnaires, direct observation, air quality studies, storm water runoff modeling, and bird surveys to generate data that was then interpreted within an evaluation framework developed by the research team in collaboration with Hort Innovation. The evaluation framework defined expected outcomes, indicators, and data sources designed to evaluate a number of social attributes, environmental attributes, and economic attributes. This section reflects on the effectiveness of the research methods and evaluation framework used.

5.1. *Social research methods and outcomes*

The participant questionnaires and direct observation were effective for evaluating the social attributes contained within the evaluation framework, and thus for answering social aspects of the research questions. Direct observation using time-lapse photography analysis enabled a comprehensive assessment of the number of visitors to the site, the activities undertaken, amenities used, and estimated duration of stay. The participant questionnaires enabled a deeper assessment of why visitors came to the site, what they liked or disliked about the site, and whether they felt a sense of attachment to the place (Scannell & Gifford 2010).

Direct observation confirmed that the site is heavily used as a pedestrian thoroughfare, which confirms its important contribution to the connectivity of the local area. However, it was difficult to encourage commuters to participate in the questionnaire, which means that these results are not representative of all users of the site, but rather only those who were not walking through the site at the time of their participation. Some questionnaire participants contributed insights as to the value of the site as a pedestrian thoroughfare, with comments about how enjoyable the walk is or that it is safer to cross Ultimo Road since the Goods Line North opened up access to the pedestrian bridge. Trying to gain a more comprehensive insight as to the perspective of commuter users of the site would be an important avenue for further research.

While there was a low level of interest among business owners in participating in interviews, they were useful for providing a high-level perspective of business in the area and whether the Goods Line had any impact on economic activity. Further research of a similar nature in the future may be able to uncover whether the Goods Line and surrounding redevelopments have had a positive impact on business or whether the improvements result in a gentrification impact with negative effects on existing business operators through displacement (Wolch et al. 2014).

5.2. *Biophysical research methods and outcomes*

The air quality study and bird surveys were useful for analysing air quality and biodiversity, however

did not find the site had any impact on these variables, save a potential mitigating impact for some pollutants on hot days. It is important to reiterate, however, that this result may be a consequence of the simplicity of the green space installed at the Goods Line North, being primarily grass areas. Improvements to air quality and biodiversity metrics resulting from urban green space developments are most commonly found where the green space includes complex vegetation, particularly trees (Escobedo et al. 2011; Goldstein et al. 1986; Currie & Bass 2008; Evans et al. 2009; Sandström et al. 2006). Future research into biophysical impacts on the Goods Line North may identify impacts on air quality and biodiversity as the site and its surroundings mature. At the same time, the results of this study underscore the importance of providing a sufficient quality of green space if an objective of the space is to improve biophysical variables such as air quality and biodiversity.

5.3. Evaluation framework and measuring change

One of the concerns evident when using an indicator-based evaluation framework is that it presents a simplified, structured way to analyse a complex social space that may lack an obvious structure. Indicators generally simplify in order to make complex phenomena quantifiable in such a manner that communication is either enabled or promoted (MacGillivray & Zadek 1995). The communication of research to a variety of audiences is a key component in the production and dissemination of knowledge, and for this project, the evaluation framework was useful for structuring the presentation and analysis of research results.

At the same time, the simplification and ease of communication using indicators can come at the cost of nuance and understanding complexity. For example, the evaluation framework suggests that an increased number of social interactions is the appropriate indicator for measuring the social attribute of 'Interaction'. While a high level of social interaction was observed at the Goods Line North, there was also a substantial presence of individuals seeking solitude and seemingly avoiding interaction (e.g. sitting alone in far reaches of the site, or sitting with their backs to the majority of the site). A strict reading of the evaluation framework would suggest that visiting the site alone is negative when it comes to encouraging interaction. Given that a majority of questionnaire respondents suggested that they visit the Goods Line to seek both social interaction and solitude, however, the fact that many visitors come alone should not be seen as something that detracts from the site's value. Rather, its capacity to accommodate both social interaction and solitude suggests that the Goods Line North is meeting the varied desires of visitors, rather than falling short when it comes to encouraging social interaction.

Arriving at conclusions as to the level of 'change' at the Goods Line North and attributing changes to the amount and quality of green space was difficult because the site was not open to the public prior to the redevelopment. As such, the Goods Line North should really be considered as a new development rather than as a redevelopment of an existing site. The research incorporated a comparison of the Goods Line North with the Goods Line South, in order to understand how visitors perceive a site with green space and varied amenities (Goods Line North) compared with an adjacent site without these features (Goods Line South). Questions comparing the two sites, as well as other questionnaire topics, enabled the research to answer questions about the role of green space in visitor's experiences and to examine how green space contributes to the attractiveness of a site.

Finally, it is important to consider that at the time of the evaluation, the site had only been open to the public for several months. While it may be the case that the further positive change associated with the Goods Line North will never eventuate, it may also be the case that enhancement will

develop over the course of several years. In fact, in the case of social and economic attributes, the contributions of the Goods Line North are likely to change as ongoing redevelopments in the immediate area (such as Darling Square and Darling Harbour) are completed. It is thus recommended to evaluate the Goods Line North again once these redevelopments are complete, to determine whether a more mature site has any further impact on social, environmental, and economic attributes.

6. Recommendations

Key recommendations from the project include:

- Green space is a highly valued and sought after component of public open space.
- If additional green space cannot be provided on a site because of space considerations, a site can provide amenities necessary for the visitors to enjoy green space that already exists (such as seats underneath existing trees), as a way of promoting access to green space and its benefits.
- Governance arrangements that promote activation of open spaces with green space is important for full benefits associated with green space to be realized.
- This evaluation should be repeated following the completion of surrounding redevelopments and in light of the wider urban renewal of the Ultimo precinct, in order to understand how the contributions of the Goods Line North mature over time and with changes to the surrounding urban fabric and its population.

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7. Scientific Refereed Publications

None to report.

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8. Intellectual Property/Commercialisation

No commercial IP generated.

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